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P01/7700 0.00-0320996.2

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Cardiff Road
Newport
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01. Your reference — RJB/GPJ/P410283GB

2. Patent application number *(The Patent Office will fill in this part)* — 0320996.2 — 9 SEP 2003

3. Full name, address and postcode of the or of each applicant (*underline all surnames*)

CRP Group Limited,
Stanley Way,
Stanley,
Skelmersdale,
Lancashire WN8 8EA

Patents ADP number (*if you know it*) — 68653640001

If the applicant is a corporate body, give the country/state of its incorporation — ENGLAND

4. Title of the invention — CLADDING

5. Name of your agent (*if you have one*) — **W.P.THOMPSON & CO.**

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Coopers Building,
Church Street,
Liverpool,
L1 3AB.

Patents ADP number *(if you know it)* — 0000158001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(Day/month/year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(Day/month/year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'yes' if:*
a) any applicant named in part 3is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

YES

9. Enter then numsber of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	7
Claims(s)	3
Abstract	1
Drawing(s)	1 + 1

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *Patents Form 10/77*)	
Any other documents *(Please specify)*	

11. I/We request the grant of a patent on the basis of this application

Signature W.P. Thompson & Co. Date September 8, 2003

12. Name and daytime telephone number of person to contact in the United Kingdom

R.J.BARTLE
0151-709-3961

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DESCRIPTION

CLADDING

The present invention relates to a cladding for suppressing vortex induced vibration of underwater pipes, cables or other elongate members.

When water flows past an underwater pipe, cable or other elongate member, vortices may be shed alternately from either side. The effect of such vortices is to apply fluctuating transverse forces to the member. Such forces can cause the member to bend more than is desirable and impose unwanted additional forces on the member's point of suspension. If the shedding frequency of the vortices is close to a natural frequency of the member then resonance effects can result in particularly severe and potentially damaging oscillation. The problem is experienced particularly in connection with marine risers of the type used in sub-sea oil drilling and extraction. It is referred to as "vortex induced vibration" or "VIV"

It is known to apply to elongate underwater members a cladding whose exterior is shaped to suppress VIV. Reference is directed in this regard to UK patent application No. 9905276.3 (publication No.2335248) which discloses an underwater cladding made up of a number of separately formed sections assembled to form a tubular structure receiving an underwater member and having sharp edged helical strakes along its length which, by controlling transition from

laminar to turbulent in a flow of water on the structure, serve to suppress VIV. The sections are moulded from polyurethane and are semi-tubular, a facing pair of such sections being assembled around the underwater member to surround it.

The cladding has proved itself in practice to be highly effective. However there are commercial pressures to produce a unit which is more economical in manufacture than the existing polyurethane cladding. Additionally the existing cladding has moderately thick walls which add to its mass and also to the area it presents to a flow, so that drag is increased. Reducing the mass and frontal area are desirable.

The present inventors have recognised that the technique of rotational moulding can be advantageously applied to the manufacture of cladding for underwater members. They have also recognised that the formation of the known VIV suppression cladding can advantageously be modified when rotational moulding is used, resulting in improvements to the product.

In accordance with a first aspect of the present invention there is a cladding section for mounting upon an elongate underwater member and suppressing vortex induced vibration of it, the section comprising a plastics moulding shaped to provide a tubular portion for receiving the member, the tubular portion being split along its length and being deformable to permit the member to be introduced

into the tubular portion, and the cladding section having at its exterior at least one feature shaped to suppress vortex induced vibration.

In accordance with a second aspect of the present invention there is a method of manufacturing a cladding section for mounting upon an elongate underwater member and suppressing vortex induced vibration of it, the method comprising rotationally moulding the cladding section in one piece.

Specific embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:-
Fig. 1 is a perspective illustration of a section of VIV suppression cladding embodying the present invention;

Fig. 2 is a section in a radial plane through part of the section of cladding illustrated in Fig. 1; and

Fig. 3 is a perspective illustration of a pair of such sections assembled in a string.

The illustrated cladding sections are manufactured by the rotational moulding process which is in itself well known and will only be very briefly explained herein. Rotational moulding is distinguished from other moulding techniques in that during the moulding process the mould is rotated, so that the material in it

forms a layer over the mould's inner surface. It is not intended to imply that the present invention is limited to any particular rotational moulding technique. However it may be further explained that rotational moulding typically involves introducing a measured quantity of thermoplastic powder to the mould and then heating the mould and rotating it. As the mould rotates the powder tends to fall to the bottom due to gravity. The heat of the mould causes the powder to form a unitary wall on the mould's interior, a process akin to sintering. Liquid resin may be used in place of powder, curing of the resin being promoted by the heated wall of the mould. Rotation may be about two axes. Alternatively, in the so-called "rock and roll" process, well suited to manufacture of elongate items such as the present cladding, the mould is eccentrically mounted so that rotation about a generally horizontal axis causes the mould to rock and so serves to distribute material along the mould's length. The result is a hollow moulding with a controlled wall thickness which, after cooling (e.g. by air or water jets) can be removed from the mould.

The illustrated cladding sections have been manufactured in one piece by rotational moulding in polyethylene, an economical material which is tough and of moderate density similar to that of water, so that the sections are approximately neutrally buoyant.

Each cladding section 8 comprises a tubular part 10, which in the present

embodiment is of circular cross section, and integrally formed VIV suppression features which in the present embodiment are formed as strakes 12. The wall of the tubular part 10 is longitudinally split at 14 and by virtue of the resilience of the material from which it is made, the section can be opened out - that is, the two sides of the split can be drawn apart - to allow the cladding section to be placed around an elongate member such as a marine riser.

The strakes 12 are best seen in Fig. 2 and have an exposed vertex 16 which tends to "trip" flow over the cladding - ie. to promote the transition from laminar to turbulent flow. The resulting controlled transition from laminar to turbulent flow typically does not give rise to vortex induced vibration. The illustrated strakes are of triangular cross section. It can be seen that they are hollow. This is a result of the rotational moulding process. The strakes protrude from the exterior of the tubular part and extend along its length but form a helix of shallow pitch. There are three parallel strakes arranged in the manner of a triple start screw thread. The result is that the cladding is equally effective for suppression V.I.V. in flows from any direction. Where a line of strakes crosses the split 14 in the tubular part 10, as at 21 in Fig. 1, the strake is omitted from that region.

In use several sections are placed end-to-end in a string covering a length of the elongate underwater member. Ends of each section are provided with complementary mating features so that they can be fixed together. These take the

form of stubs 18 in the illustrated embodiment but it is anticipated that in a production version there may simply be a "joggle" - an enlarged diameter section at one end of each section to form a socket receiving the non-enlarged adjacent end of the neighbouring section.

The cladding can be secured in place by means of tension bands placed around it at intervals along the cladding's length. Note that the strakes are interrupted e.g. at 20, 22 to permit the bands to be applied without crushing the strakes. Suitable bands are known in this art. Typically a band is applied around each of the junctions between adjacent sections to secure them together.

Prototype claddings of the illustrated type have been found to be more than four times lighter than equivalent polyurethane cladding. The thin walls and hollow strakes of the illustrated cladding contribute to this weight reduction. As a consequence of its low weight, the illustrated cladding is relatively easy to handle and install.

It is desirable to provide the cladding with protection against marine fouling - accretion of biological material on its surface. This can be advantageously achieved in a cladding embodying the present invention by a moulding technique referred to as "double shotting". In this technique the wall of the moulding is built up in two layers. Firstly an anti-fouling material is introduced to the mould

and forms an outer layer of the moulding which can be relatively thin. A structural inner layer is then formed by introducing a different material - in this case polyethylene - and continuing the rotational moulding process. The anti-fouling material forming the outer layer is relatively expensive but the technique allows good use to be made of this material. The double (or multiple) shotting technique can also be used to provide the product with a shallow exterior coloured layer or with visual markings.

CLAIMS

1. A cladding section for mounting upon an elongate underwater member and suppressing vortex induced vibration of it, the section comprising a plastics moulding shaped to provide a tubular portion for receiving the member, the tubular portion being split along its length and being deformable to permit the member to be introduced into the tubular portion, and the cladding section having at its exterior at least one feature shaped to suppress vortex induced vibration.

2. A cladding section as claimed in claim 1 which is a rotational moulding.

3. A cladding section as claimed in claim 1 or claim 2 wherein the vortex induced vibration suppression feature is a hollow projection.

4. A cladding section as claimed in claim 3 wherein the feature is an elongate hollow strake.

5. A cladding section as claimed in any preceding claim which comprises polyethylene.

6. A cladding section as claimed in any preceding claim which comprises an outer layer of anti-fouling material and an inner structural layer.

7. A cladding section as claimed in any preceding claim, end portions of which are provided with mating features for mating with adjacent cladding sections.

8. A method of manufacturing a cladding section for mounting upon an elongate underwater member and suppressing vortex induced vibration of it, the method comprising rotationally moulding the cladding section in one piece.

9. A method as claimed in claim 8 comprising moulding the cladding section with a tubular body which is longitudinally split, and is deformable to permit the member to be introduced into it.

10. A method as claimed in claim 8 or claim 9 comprising moulding the cladding section with at least one hollow protruding feature for suppressing vortex induced vibration.

11. A method as claimed in any of claims 8 to 10, comprising a two shot moulding process forming an outer anti-fouling layer and an inner structural layer.

12. A cladding section substantially as herein described with reference to, and as illustrated in, the accompanying drawings.

13. A method of manufacturing a cladding section substantially as herein described with reference to, and as illustrated in, the accompanying drawings.

ABSTRACT

CLADDING

There is disclosed a cladding section 8 for mounting upon an elongate underwater member and suppressing vortex induced vibration of it, the section comprising a unitary plastics moulding shaped to provide a tubular 10 portion for receiving the member, the tubular portion being split along its length at 14 and being deformable to permit the member to be introduced into the tubular portion, and the cladding section having at its exterior at least one feature 12 shaped to suppress vortex induced vibration. Rotational moulding of the cladding section is disclosed.

Fig.1

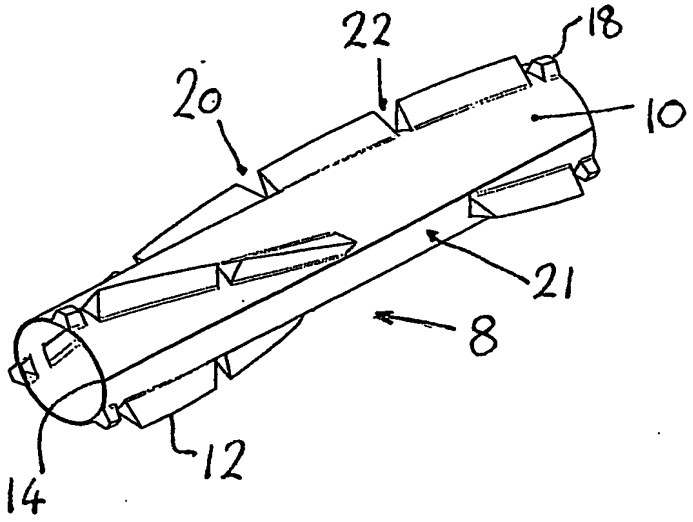

Fig.2

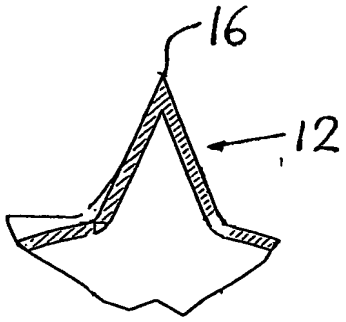

Fig.3